Space Weather Technical Forecast

Issued on Tuesday, 04 October 2022 at 01:26 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: G1/Minor storms possible, mainly Day 1. Ongoing likelihood of M-class flares with chance of isolated X-class flares due to AR3110 and AR3112.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Moderate in the past 24 hours, with multiple M1-4 class flares from AR3112 and AR3110. There are currently seven numbered sunspot regions on the visible disc. AR3110 in the NW appears to have simplified slightly into a Dac/Beta group. Nearby AR3113 is magnetically simple, but likely adds to the instability of the north-south aligned magnetic field around AR3110. The largest region on the disk is AR3112, a longitudinally wide area in the northeast, with a complex magnetic field. The trailing part appears to have decayed a little, but its intermediate portion remains large and complex. AR3115 in the southern hemisphere, approaching the meridian, has shown some further slight growth, whilst widening. Other spot groups are much simpler and either stable or showing slight decay.

In the last 24 hours, two CMEs were observed directed to the northwest following M4 and M1 flares from AR3110 during the 3rd. The first of these was modelled and is a clear miss ahead of Earths orbit.The second followed a near identical trajectory and was narrower, and is also assessed as being well off the Sun-Earth line. Another CME from a filament eruption in the southeast late on the 2nd has now been analysed, and has a very slight chance of glancing Earth day 3 (6th). However, this is low confidence, and any significant impacts are considered very unlikely.

Solar Wind / Geomagnetic Activity: Solar wind parameters at L1, as measured by DSCOVR/ACE, have remained at slightly-elevated to elevated levels, between 450 km/s and 600 km/s. This may be due to impacts of CH28/+. Density has been average or below average. The total IMF, Bt, was mostly weak at 5-8nT, but climbed to moderate levels of 15nT for a time in the second half of the UTC day. The north-south component, Bz, showed two periods of moderate southward direction between midday UTC and 03/1930 UTC, peak -12nT. The phi angle was positive (away from the Sun). The resultant geomagnetic activity was mainly Quiet to Active (Kp 1-4), but with a G1/Minor Storm (Kp 5) interval 03/1800-2100 UTC.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) as measured at GOES16, is currently just above normal background levels, but well below the S1/Minor Storm threshold following a slight increased in response to the X1.0 flare of AR3110. High energy electron flux (greater than 2 MeV) was at background to moderate levels. The associated 24-hour fluence remained well below the Active (1e8 integrated pfu) threshold, but on a rising trend. Observed fluence at 04/0001 UTC was 6.14e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is forecast to be Moderate, with a chance of High levels, due to likely further M-flares or perhaps X-flares possible from AR3110 and AR3112.

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Solar Wind / Geomagnetic Activity: There are potentially several CMEs which could influence Earth, all from near the sunspot group in the northwest. The most likely of which left the Sun on the 1st, could potentially arrive early on day 1 (4th), although this is low confidence with a glancing impact most likely. The uncertainty around these CMEs gives very low confidence in the forecast. Otherwise current elevated to slightly elevated winds are expected to only gradually ease by the end of the period. Geomagnetic activity is forecast to be mainly Unsettled to Active day 1 (4th) with a chance of further G1/Minor Storms, especially with any CME influences. Otherwise, a general trend back towards Quiet to Unsettled is likely through the period.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10MeV) is expected to be near background for much of the period, but with a slight chance of rising above the S1 level through the period due to any further M or X-flares that occur, mainly from AR3110 or AR3112. The high energy (greater than 2MeV) electron flux is likely to rise due to the recent elevated winds. In the absence of any CMEs, this would occur later day 1 and through the rest of the period, with an increasing chance of flux becoming persistently High. However, this is uncertain due to the potential CME impacts, with any rise likely occurring once their influence subsides. The associated 24 hour fluence will likely stay below the Active threshold until at least day 3 (6th), but with an increasing chance of rising above.

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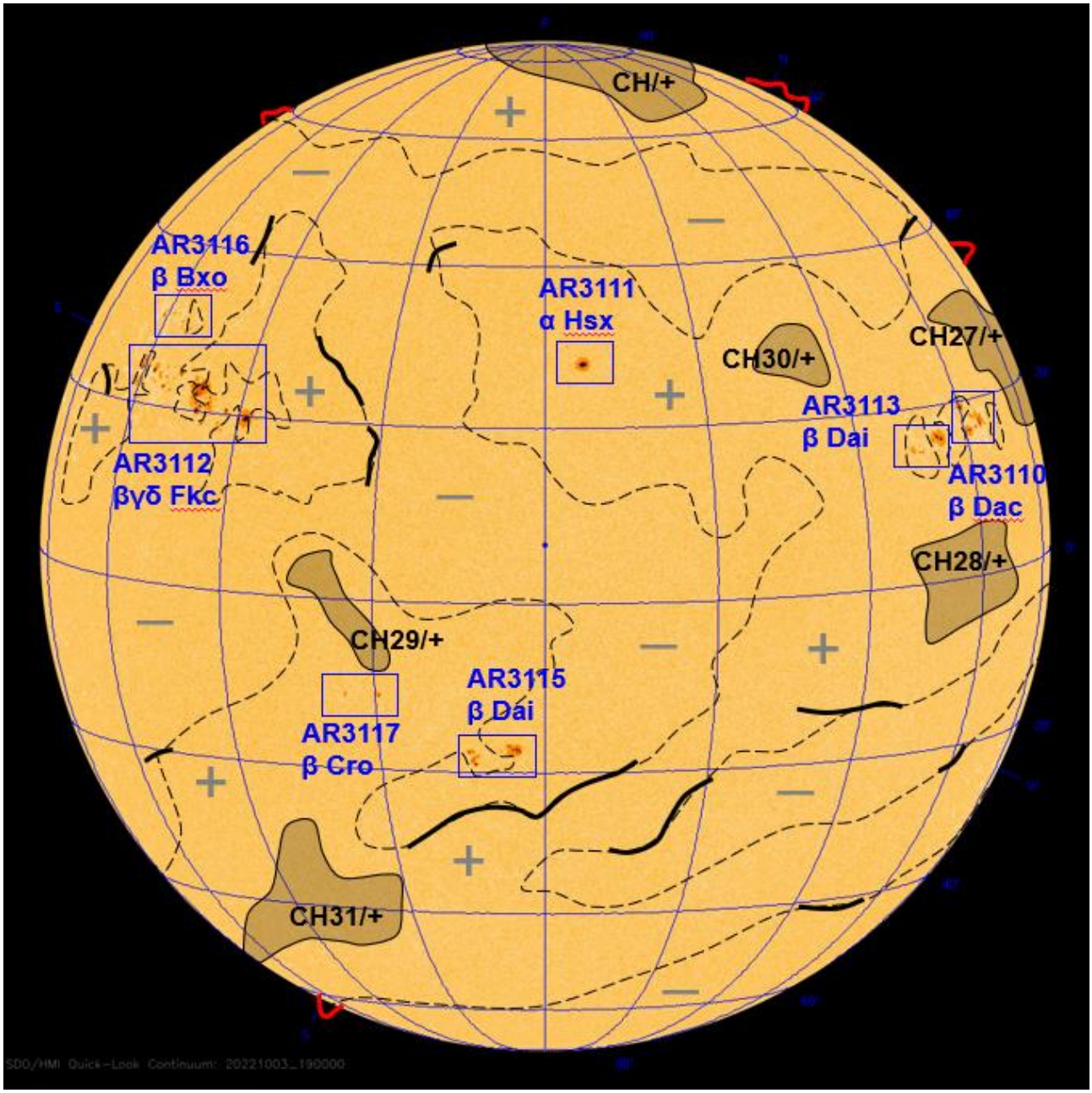
Figure 1. Solar Analysis Valid 03/1900 UTC.



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Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

Multiple CMEs have erupted from the northwest quadrant in the past 48 hours, the most recent two following M4 and M1 flares from AR3110 on the 3rd. The first of these was modelled and is a clear miss ahead of Earths orbit.The second followed a near identical trajectory and was narrower, and is also assessed as being well off the Sun-Earth line.

Prior to these, four CMEs from the northwest were considered as having the potential for Earth-directed ejecta, although with low confidence. The most likely to impact originated from a filament eruption to the east of AR3113 at 01/1200 UTC. Two further CMEs from AR3110 associated the M5.8 and M8.3 flares at 01/2010 and 02/0220 UTC were mainly directed away from Earth, however these have a chance to give glancing impacts. A further CME from the X1.0 of AR3110 at 02/2025 UTC was analysed missing Earth. Another CME from a filament eruption in the southeast late on the 2nd has been analysed, and has a very slight chance of glancing Earth day 3 (6th). However, this is low confidence, and any significant impacts are considered very unlikely.

The CME from 1st Oct is the most likely to provide impacts at Earth, possibly arriving early day 1 (4th). However, confidence remains low on the strength of any potential impact. The following CMEs are likely to only give glancing impacts at most, although perhaps re-enhancing conditions through day 2 and into day 3 (4th to 5th), although this is also very low confidence.
Earth has been in the fast wind of CH28, with slightly elevated or elevated solar winds likely to persist into day 3 (6th), with some contribution also likely from CH30/+. There remains a great deal of uncertainty due to the low confidence surrounding CME arrival times and impacts.
Geomagnetic activity is forecast to be mainly Unsettled to Active day 1 (4th) with a chance of further G1/Minor Storms, especially with any CME influences. Otherwise, a general trend back towards Quiet to Unsettled is likely through the period.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	**G1 to G2**	Yes	60	20	5	5
Strong	**G3**	No	15	1	1	1
Severe	**G4**	No	2	1	1	1
Extreme	**G5**	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
01/1625 UTC	Partial Halo	AR3113	NW	1000km/s	03/2359UTC +/- 12 hours	Low confidence glancing blow

Figure 2: MOSWOC Enlil showing possible CME arrival.

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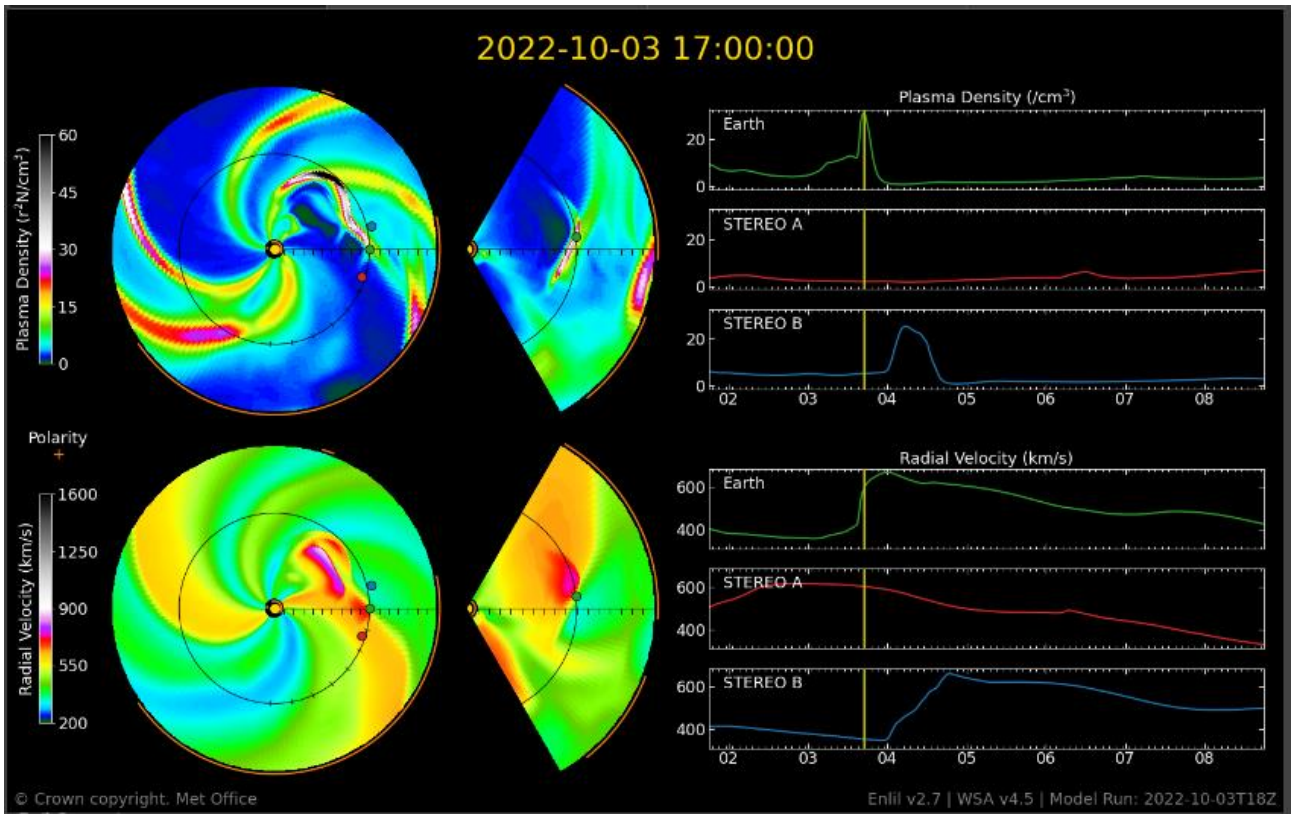

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Radio Blackouts - X-Ray Flares:

There are currently seven numbered sunspot regions on the visible disc. AR3110 in the NW appears to have simplified slightly into a Dac/Beta group. Nearby AR3113 is magnetically simple, but likely adds to the instability of the north-south aligned magnetic field around AR3110. The largest region on the disk is AR3112, a longitudinally wide area in the northeast, with a complex magnetic field. The trailing part appears to have decayed a little, but its intermediate portion remains large and complex. AR3115 in the southern hemisphere, approaching the meridian, has shown some further slight growth, whilst widening. Other spot groups are much simpler and either stable or showing slight decay.

Solar activity has been Moderate in the past 24 hours, with multiple M1-4 class flares from AR3112 and AR3110. Further M-flares are expected, with a chance of isolated X-class flares from AR3110 or AR3112.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	80	80	70	70
Very Active	R3 to R5 X Class	No	30	30	25	25

Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10MeV) as observed by GOES16 was initially slightly above background following the X-flare of AR3110 on the 2nd, but well below the S1-level. Further such rises are possible with a slight chance of exceeding this threshold, primarily from any further M or X-flares from AR3110, but potentially also from AR3112 in the northeast given a sufficiently strong flare event.

Radiation Storms	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ S1	No	20	20	15	15
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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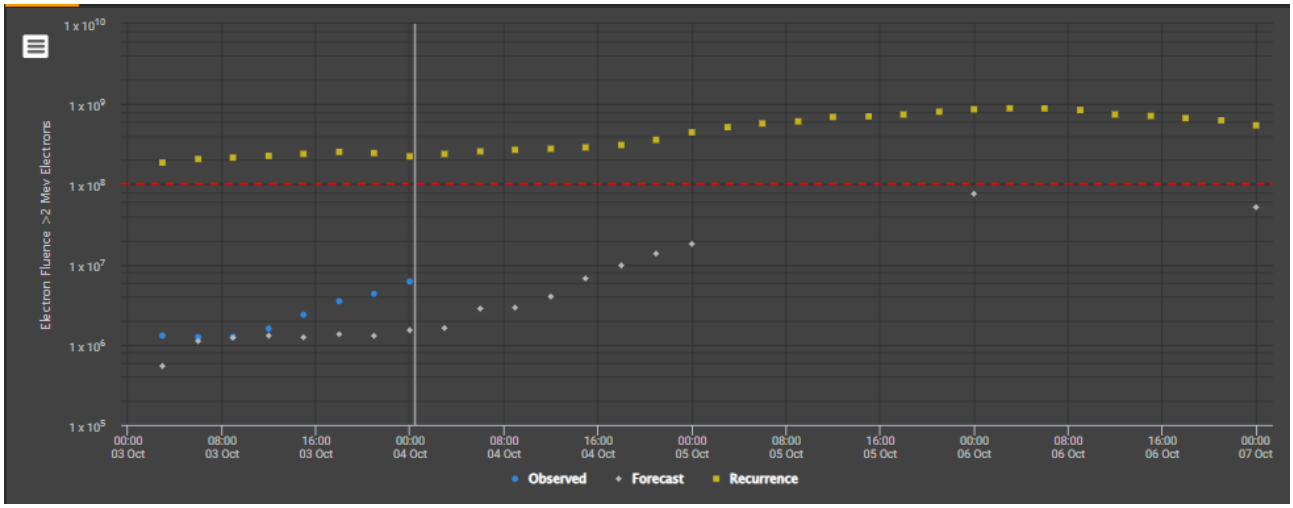
High Energy Electrons Event (≥ 2MeV):

The high energy (greater than 2MeV) electron flux has been at background to moderate levels. Any rise in electron flux due to the slightly elevated wind speeds may be complicated by potential CME influence on day 1 (4th), which could then suppress electron levels. Once any CME influence subsides, or if the arrivals are weak/don't materialise, then flux levels are expected to become increasingly High, from day 1 (4th), but particularly day 2 (5th) onward. If no CME arrival occurs, increasingly prolonged periods of high flux are possible from later day 1 (4th) onward

The associated electron 24 hour fluence is likely to remain below the Active (1e8 integrated pfu) threshold, but with a rising trend and with some significant uncertainty due to the potential CME glances. Should these miss, there is the potential for electron fluence to rise close to, or above, Active by days 3 and 4 (6th and 7th). REFM is currently giving generally good guidance for an upwards trend, but only in the absence of any CME arrival.

GEO Electron Environment	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	No	10	30	60	50
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	5

Figure 3: MOSWOC REFM



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